Impact of Climate Change on Smallholders' Rubber Production in Songkhla Province, Southern Thailand

Sayan Sdoodee[1] and Sopon Rongsawat[1]
[1]Department of Plant Science, Faculty of Natural Resources
Prince of Songkla University, Hat Yai, Songkhla 90112, Thailand
Telephone: 0-7428-6150 E-mail: sayan.s@psu.ac.th

Abstract

Southern Thailand normally is the main area of rubber plantation because of suitable climate, particularly with Songkhla province where is a main rubber production (7,564,062 hectares) in southern Thailand. However, recently climate change in this area has been evident, this may impact on smallholders' rubber production. Therefore, the effect of climate change on rubber production in Songkhla province was investigated. Meteorological data in Songkhla province during 30 years (1981-2010) was analyzed to exhibit climate change scenario. It was found that maximum and minimum temperatures trended to increase 0.52°C/30 years and 0.55°C/ 30 years, respectively. Annual rainfall and rainy days also trended to increase. Total latex yield and average latex yield per year in Songkhla province during 5 years (2006-2010) from ORAFF showed that they trended to decrease with an increase of annual rainfall during that period. Besides, four smallholders' rubber plantation in Hat Yai district, Songkhla province were sampled to conduct the effect of rainfall fluctuation on tapping days. It was found that high rainfall trended to decrease tapping days per year. From the results, it is suggested that climate change and climate variability in Songkhla province trends to reduce latex yield because of an increase of rainfall leading to a reduction of tapping days.

Keywords: Climate change, *Hevea brasiliensis*, Songkhla

1. Introduction

Global warming is the increase of Earth's average surface temperature [1]. It has become clearly more and more intense, is evident from the change of climate. This is caused by man-made or anthropogenic emissions of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), ozone (O_3) and nitrous oxide (N_2O) [2]. The increase of these gases in the atmosphere, causing global temperatures to rise around the world [3].

In the tropics, rainfall is the most variable element of climate which has relationship with surface temperature [4]. The violence that followed the distribution of rain is unusual in this region, causing prolonged droughts, intense flooding and severe storms to occur more frequently [5]. Global warming is a major impact on the available water resources, drought potential and agriculture productivity [6]. In Thailand, crop productions: rice, oil palm, tropical fruit and rubber tree which are mostly from rainfed agriculture. Climate change may cause fluctuated rainfall distribution which could exert a negative effect on the growth and productivity. Sdoodee [7] reported that the increasing trends of maximum and minimum temperatures were found during the last decade, whereas there has been a decrease in the rainfall treads, caused the changes of flowering and fruit development period of mangosteen, this led to low yield and poor fruit quality.

Rubber tree (*Hevea brasiliensis*) is an economic crop of Thailand. Most plantation areas are in the southern region where is the traditional rubber area.

Rubber plantations in Thailand are dominated by the smallholder with small scale of production, characterized as production cultivated from four hectares or less [8]. The rubber tree is originally from the tropical rain forest. It normally, with the temperature range for growth is between 22 -35°C. Yew and Sys [9] suggested that the climatic features suitable for rubber cultivation include high mean daily air temperature of 25-28°C, high rainfall exceeding 2,000 mm year^{-1} and yet not interfering with tapping and latex collection. The rain must be evenly distributed through the year and with not more than one dry month. Ideally, the number of rainy day should range from 100-150 days [10]. Recently, there has been continuous warning signals of higher rainfall with intense floods and drought in Malay Peninsular: the area contains the southern- most tip of Burma, Peninsular Malaysia and southern Thailand where is traditional rubber plantations. Tawang *et al.* [11] reported that the average rubber yield in Malaysia loss for the El Nino years (EY) was 7.33%, while average rubber yield loss for the non- El Nino years (NEY) was 4.33%. Hence, the objective of this study was to investigate the impact of climate change on smallholders' rubber production in Songkhla province, southern Thailand.

2. Materials and Methods

Climate change

Data of maximum and minimum temperatures, annual rainfall during 30 years (1981-2010) from Kho Hong agro-meteorological station at Hat Yai district, Songkhla province were used to plot annual maximum and minimum temperatures, annual rainfall and rainy days per year.

- Latex yield and annual rainfall

Data of total latex yield year^{-1} and kg hectare^{-1} year^{-1} in Songkhla province. Five connective years (2006-2010) from ORAFF in Songkhla province. Then, annual rainfall during that period (2008-2010) was plotted to compare with the change of latex to assess the trend of changing.

- Latex yield and tapping day in the smallholders' rubber plantation

During 3 consecutive years (2008-2010), four rubber plantations or four sample sites (A1, A2, A3 and A4) with clones RRIM600 at Hat Yai district, Songkhla province were sampled for the assessment of tapping days and latex yield under weather condition of Songkhla province during 2008-2010. Besides, analyzed means of rainfall, rainy days, sunshine, tapping days and latex yield during 2008-2010 were compared using Duncan's multiple range test at the 5% level of significance.

3. Result and Discussion

It was evident that maximum and minimum temperatures of Songkhla province during 30 years trended to increase 0.52°C/30 years and 0.55°C/ 30 years, respectively (Figure 1a and 1b) as reported by Limsakul and Limjirakan [12] that annual maximum, minimum and average temperatures during 55 years trended to increase 0.86, 1.45 and 0.95°C, respectively. Annual rainfall during 30 year increase 29.07 mm above average value, annual rainy days also increase around 2.51 days above average value (Figure 1c and 1d). This indicated that Songkhla province has been under the influence of global warming leading to high annual rainfall and rainy days. This may affect physiological response of rubber trees. Kositsup *et al.* [13] reported that temperatures above 38°C affected photosynthesis rates of rubber leaves. However, the growth rates reduced when the average temperature above 28°C [14].

The amount of rainfall and rainy day in the summer season (January-March) and the monsoon season (October-December) during 30 years were analyzed. It was found that annual rainfall in summer season increase 36.19 mm above average value (Figure 2a and 2b), annual rainy days also increased around 2.22 days above average value. Annual rainfall and annual rainy days in monsoon season trended to increase 70.11 mm and 1.86 days, respectively (Figure 3a and 3b). There was an increase of rainfall during summer, causing fall leaflets due to the infection of powdery mildew disease [15]. The infection may cause twice defoliations [16]. This a led to poor refoliation of rubber trees.

Figure 4 also showed that increasing annual rainfall was positively related to total latex yield or kg hectare-1 year-1 of rubber trees during 2006-2010

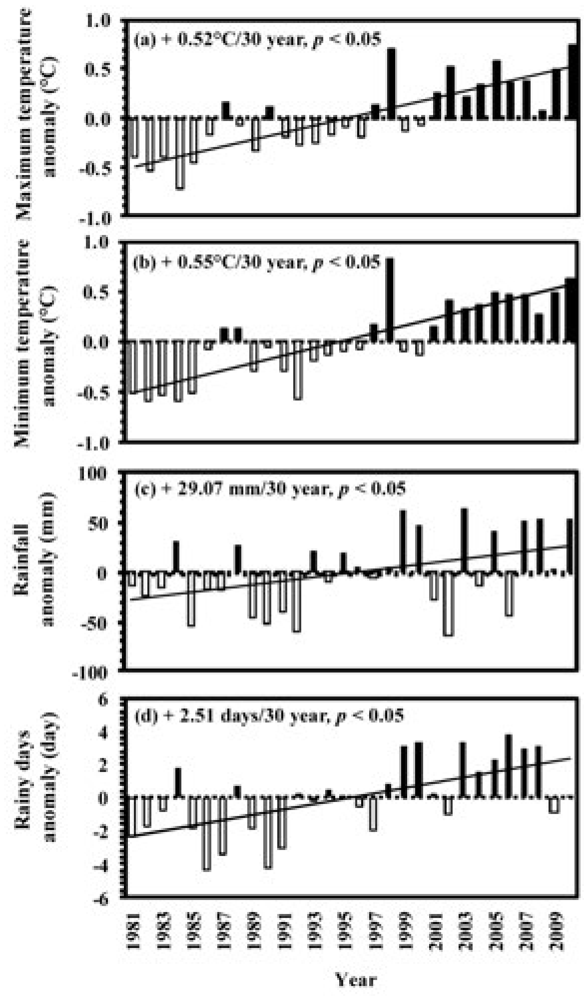

Figure 1 Anomaly and trend of maximum (a), minimum (b) temperatures, rainfall (c) and rainy days (d) during 1981-2010 in Songkhla province.

This result supported that rainfall is a main climatic factor that influences on latex yield, an increase of rainfall can cause a loss of crop due to rainfall interference with tapping; yield losses reported range between 13-30% [17]

According to the scale of individual smallholders' rubber production and climatic factors (rainfall, rainy day and sunshine) during 2008-2010 (Table 1), which affect tapping days and latex yield. In 2010, there was a significantly high rainfall (2,796.6 mm) while it was lowest rainy days and tapping days. This implied that climate change with an increase of higher rainfall in each rainy day, led to a reduction of tapping days because of heavy rains and flooding. Joseph and Jacob [18] reported that the extreme weather in terms of long and intense dry spells and heavy rains can substantially reduce harvesting intensity through reduced tapping days. The increase of rainfall giving prolonged periods in monsoon season in 2010 imposing to unusual leaf fall (*Phytophthora* leaf fall) at the A1 simple site, causing losses tapping day and latex yield . Jacob and Satheesh [19] reported that the climate change as a result of global warming can influence the growth and productivity of natural rubber in various direct and indirect ways. For example, an extreme weather event like drought or storm directly impacts growth and productivity. Changes in weather pattern can affect the incidence of pests and diseases and thus indirectly affect the crop.

The sunshine was significantly difference in years. In particular, in 2009, the latex yields were higher than year 2008 and 2010 because of the sunshine was highest. In general, sunshine or radiation (PAR: 400-700) is the most important component affecting photosynthesis. In *Hevea*, sucrose produced by photosynthesis is substrate of latex production [20]. Rao *et al*. [21] reported that the radiation, ambient temperature and vapor pressure deficit (VPD), play an important role in maintenance of plant water status, thereby influencing latex vessel turgor and latex output.

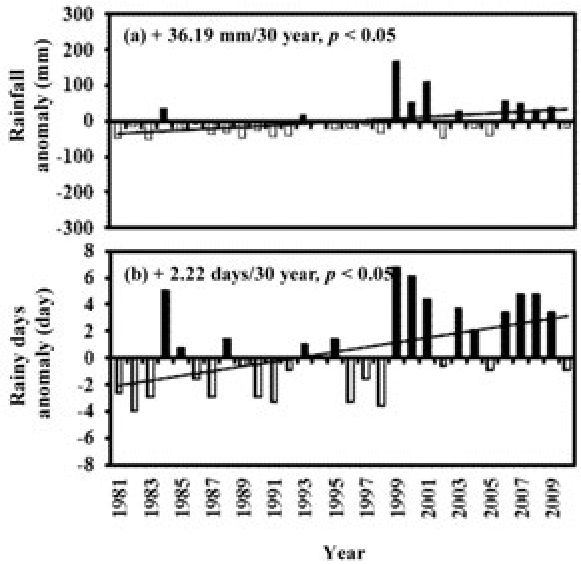

Figure 2 Anomaly and trend of rainfall (a) and rainy days (b) in the summer (January-March) during 1981-2010 in Songkhla province.

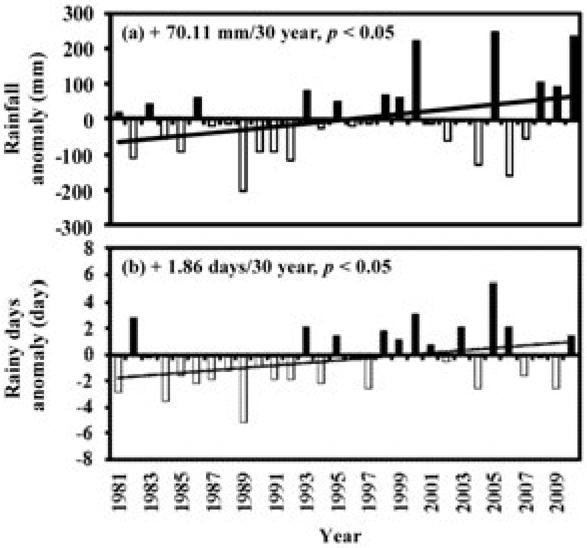

Figure 3 Anomaly and trend of rainfall (a) and rainy days (b) in the monsoon (October-December) during 1981-2010 in Songkhla province.

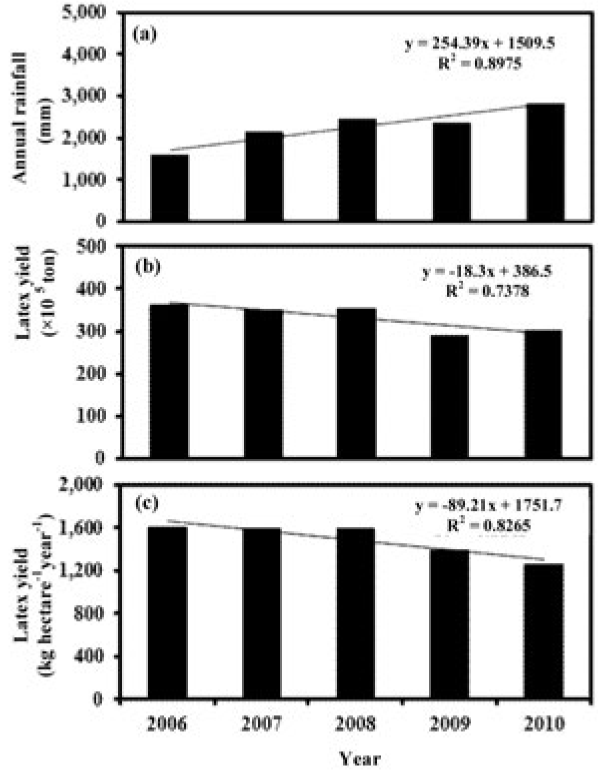

Figure 4 Annual rainfall (a), latex yield (×10 ^{5} ton) (b) and latex yield (kg hectare^{-1}year^{-1}) (c) in Songkhla province during 2006-2010.

Climate change affects the tapping days due to high rainy days, relatively higher temperature and outbreak of diseases. Therefore, the farmer will need to install sheltering to contribute tapping during rainy days. Then, it will increase tapping days under climate change condition. This also suggested that the rubber smallholders’ production and adaptation needs to be investigated further. Then, rubber production in Songkhla province will be sustainable under climate change.

Table 1 Average of rainfall, rainy days, sunshine, tapping days and latex yield at Hat Yai district, Songkhla province during 2008-2010. (A1, A2, A3 and A4 are the simple sites)

Year	Rainfall (mm.)	Rainy days	Sunshine (hr $month^{-1}$)	Tapping days				Latex yield (kg t^{-1} $month^{-1}$)			
				A1	A2	A3	A4	A1	A2	A3	A4
2008	2,268.5 b	166 a	45.3 b	150 a	98 b	124 b	84 b	3.5 b	1.7 a	2.4 b	1.0 b
2009	2,171.3 b	157 a	71.0 a	181 a	112 a	160 a	152 a	5.3 a	2.1 a	4.2 a	2.8 a
2010	2,796.6 a	154 a	47.0 b	116 b	96 b	124 b	83 b	2.7 b	1.9 a	3.4 b	2.0 a
F-test	*	ns	*	*	*	*	*	*	ns	*	*
C.V. (%)	19.75	17.71	17.64	20.15	23.22	19.78	19.22	15.21	15.68	15.29	14.34

* = Means with different letters are significant difference (P ≥ 0.05) by Duncan's multiple range test.
ns = Nonsignificant different.

4. Conclusion

According to 30-year meteorological data, climate change in Songkhla province was evident with increasing of maximum and minimum temperatures, annual rainfall and rainy days. Higher rainfall trended to be a main climatic factor causing the decreases of tapping days and latex yield.

5. Acknowledgements

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